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Morotomi et al.

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(54) **SANITARY WASHING APPARATUS**

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E03D 9/08 (2006.01)

(52) **U.S. Cl.**
CPC ***E03D 9/08*** (2013.01)

(58) **Field of Classification Search**
CPC E03D 9/08; E03D 9/085; A47K 7/08
USPC 4/420.2, 443
See application file for complete search history.

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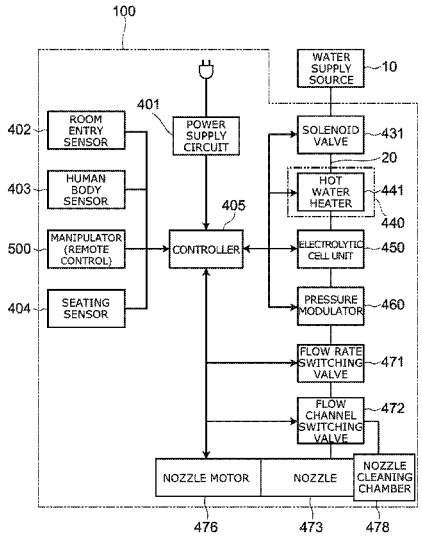
(57) **ABSTRACT**

According to one embodiment, a sanitary washing apparatus includes: a nozzle including a jetting port and configured to squirt water from the jetting port to wash a user's body; a flow channel configured to guide water supplied from a water supply source to the jetting port; an electrolytic cell provided midway along the flow channel and being operable to produce sterilizing water; a heating device provided on the flow channel on upstream side of the electrolytic cell; a nozzle cleaning device configured to clean or sterilize the nozzle with the water heated by the heating device or the sterilizing water produced by the electrolytic cell; and a controller configured to perform control for stopping energization of the heating device or reducing an amount of energization of the heating device when energizing the electrolytic cell.

9 Claims, 8 Drawing Sheets



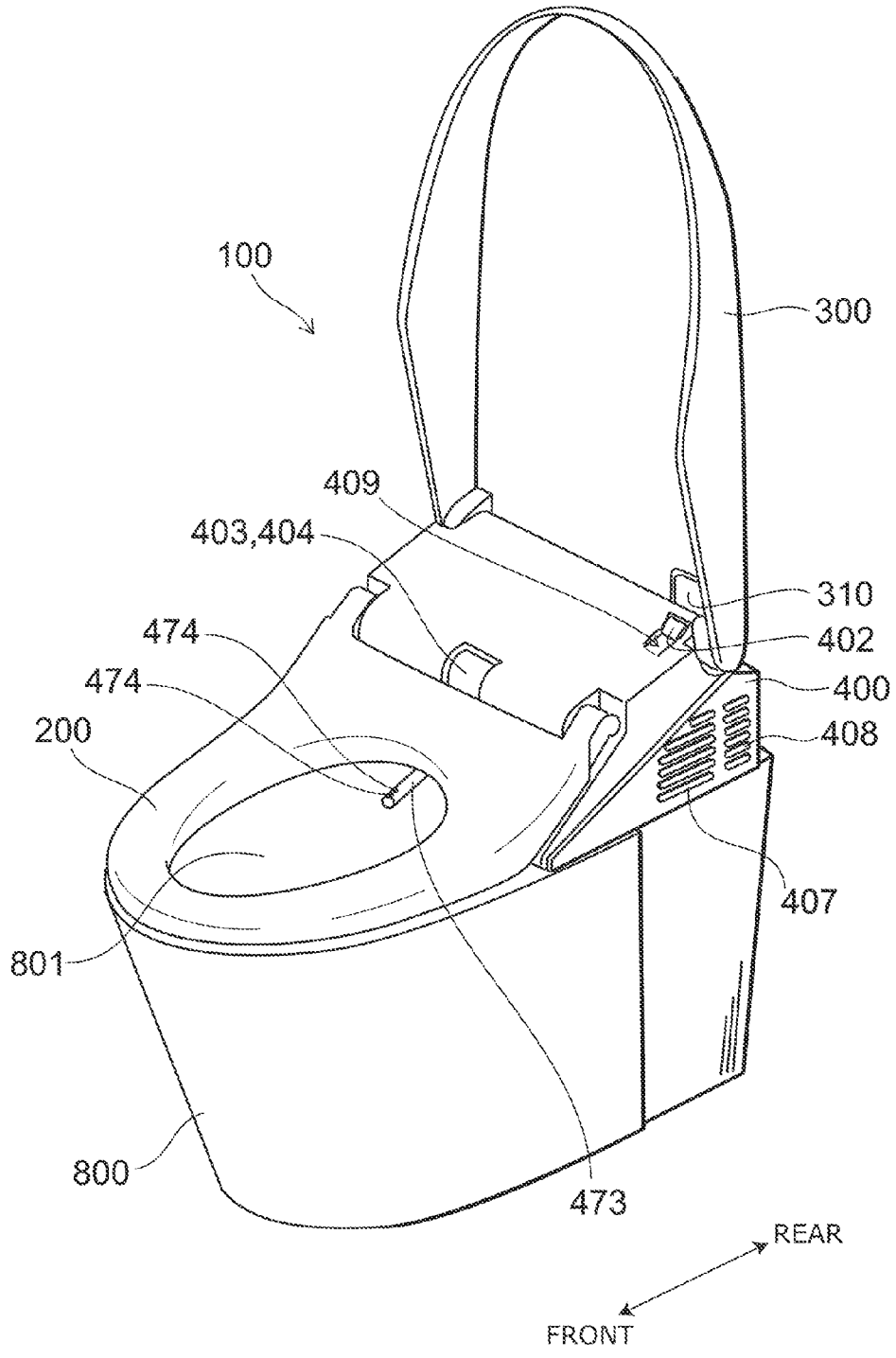

100
300
409
403,404
310
402
474
400
474
408
200
407
801
800
473
REAR
FRONT

FIG. 1

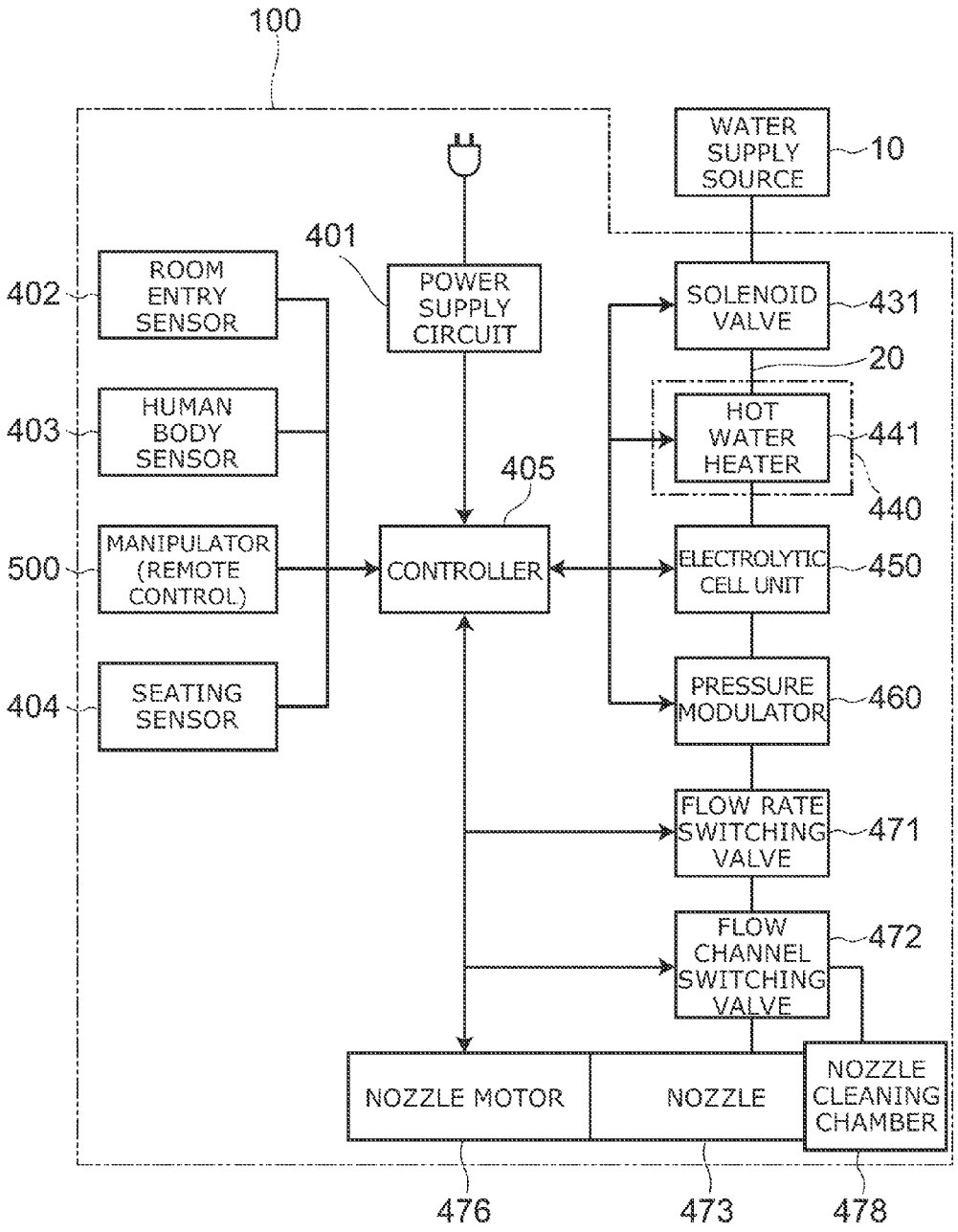

100
WATER SUPPLY SOURCE
10
401
ROOM ENTRY SENSOR
402
POWER SUPPLY CIRCUIT
SOLENOID VALVE
431
20
HUMAN BODY SENSOR
403
HOT WATER HEATER
441
440
405
MANIPULATOR (REMOTE CONTROL)
500
CONTROLLER
ELECTROLYTIC CELL UNIT
450
SEATING SENSOR
404
PRESSURE MODULATOR
460
FLOW RATE SWITCHING VALVE
471
FLOW CHANNEL SWITCHING VALVE
472
NOZZLE MOTOR
NOZZLE
NOZZLE CLEANING CHAMBER
476
473
478

FIG. 2

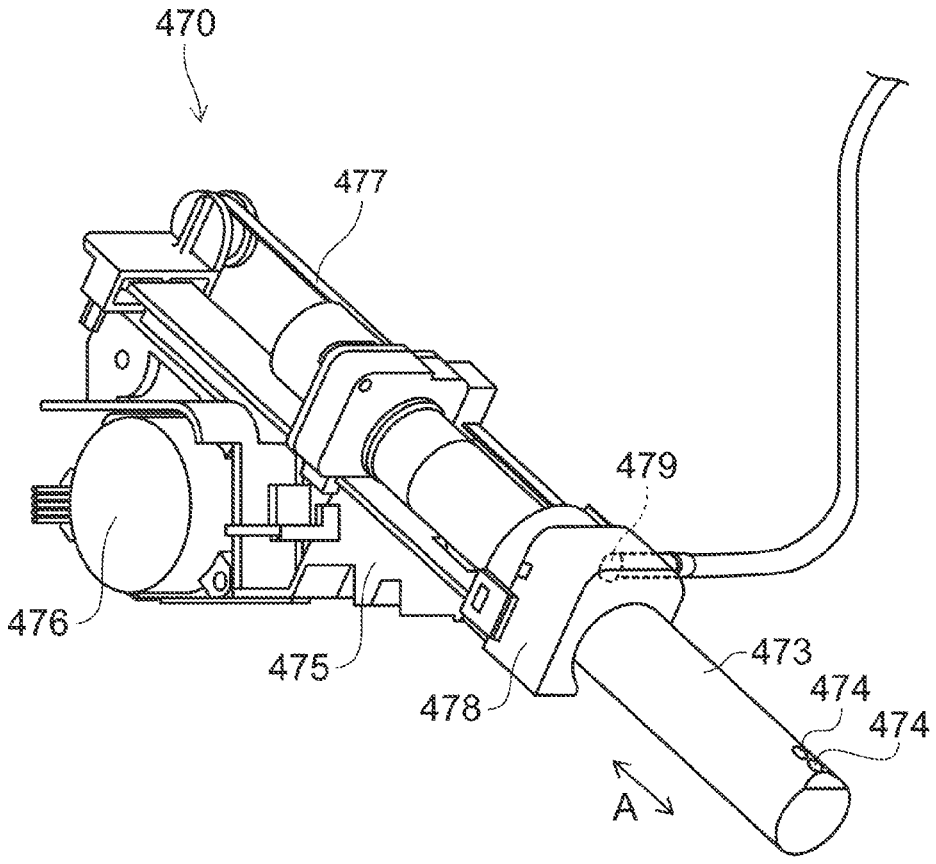


FIG. 3

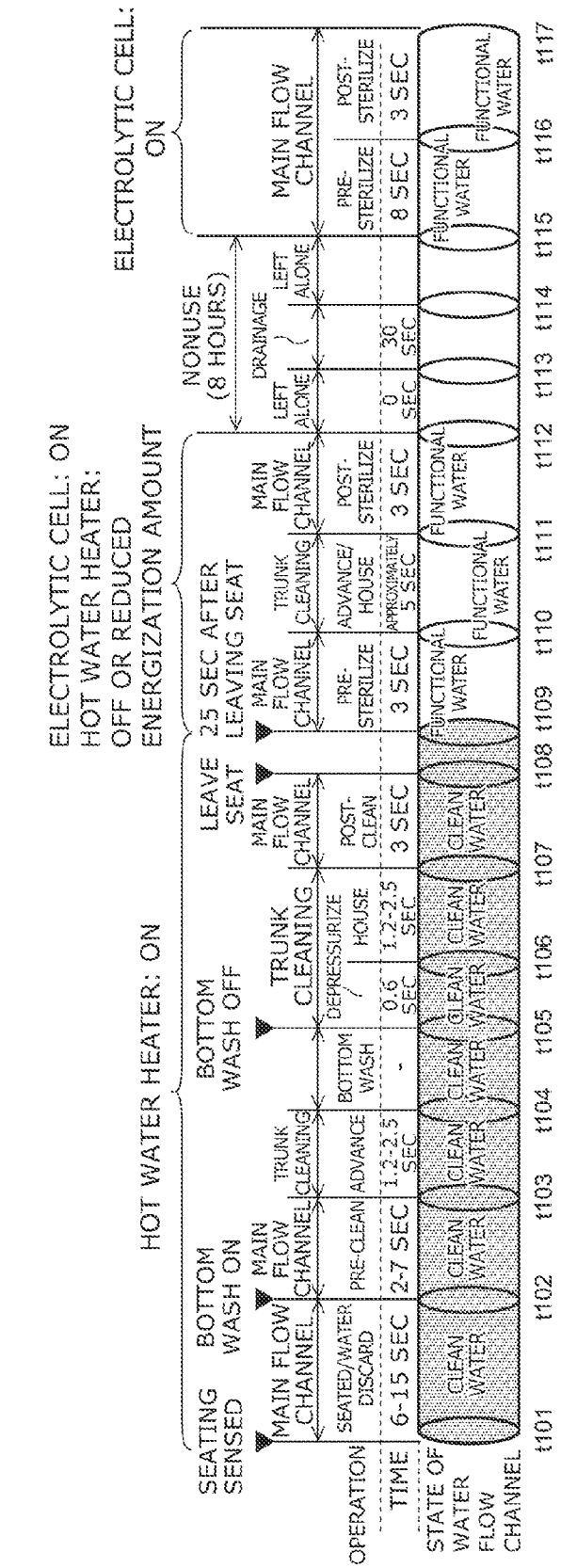

HOT WATER HEATER: ON
ELECTROLYTIC CELL: ON
HOT WATER HEATER; OFF OR REDUCED ENERGIZATION AMOUNT
ELECTROLYTIC CELL: ON
SEATING SENSED
BOTTOM WASH ON
BOTTOM WASH OFF
LEAVE SEAT
25 SEC AFTER LEAVING SEAT
NONUSE (8 HOURS)
MAIN FLOW CHANNEL
TRUNK CLEANING
DRAINAGE
LEFT ALONE
PRE-STERILIZE
POST-STERILIZE
OPERATION
TIME
STATE OF WATER FLOW CHANNEL
SEATED/WATER DISCARD
PRE-CLEAN
ADVANCE
BOTTOM WASH
DEPRESSURIZE / HOUSE
POST-CLEAN
ADVANCE/ HOUSE
6-15 SEC
2-7 SEC
1.2-2.5 SEC
0.6 SEC
3 SEC
APPROXIMATELY 5 SEC
0 SEC
30 SEC
8 SEC
CLEAN WATER
FUNCTIONAL WATER
t101
t102
t103
t104
t105
t106
t107
t108
t109
t110
t111
t112
t113
t114
t115
t116
t117

FIG. 4

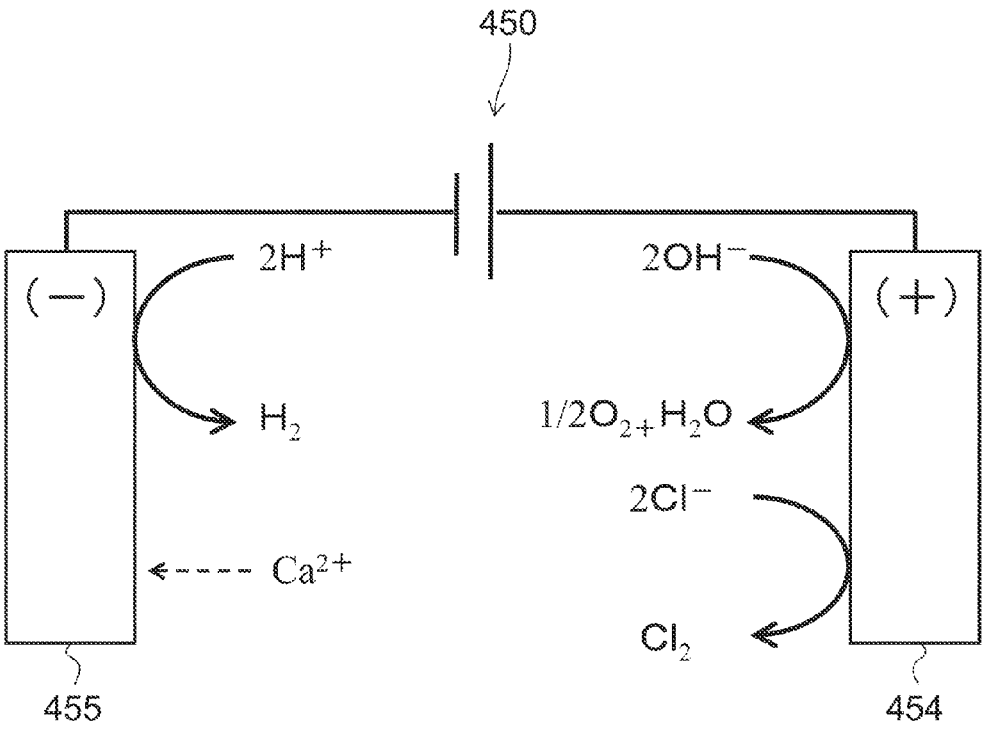

450
(−)
(+)
2H+
2OH−
H2
1/2O2+H2O
2Cl−
Ca2+
Cl2
455
454

FIG. 5

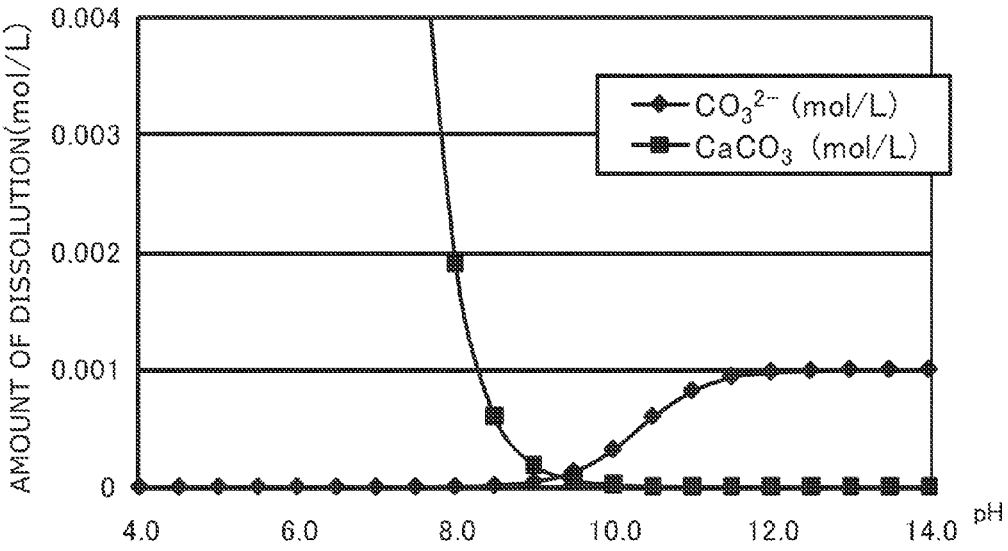

AMOUNT OF DISSOLUTION(mol/L)
0.004
0.003
0.002
0.001
0
4.0
6.0
8.0
10.0
12.0
14.0
pH
CO3 2− (mol/L)
CaCO3 (mol/L)

FIG. 6

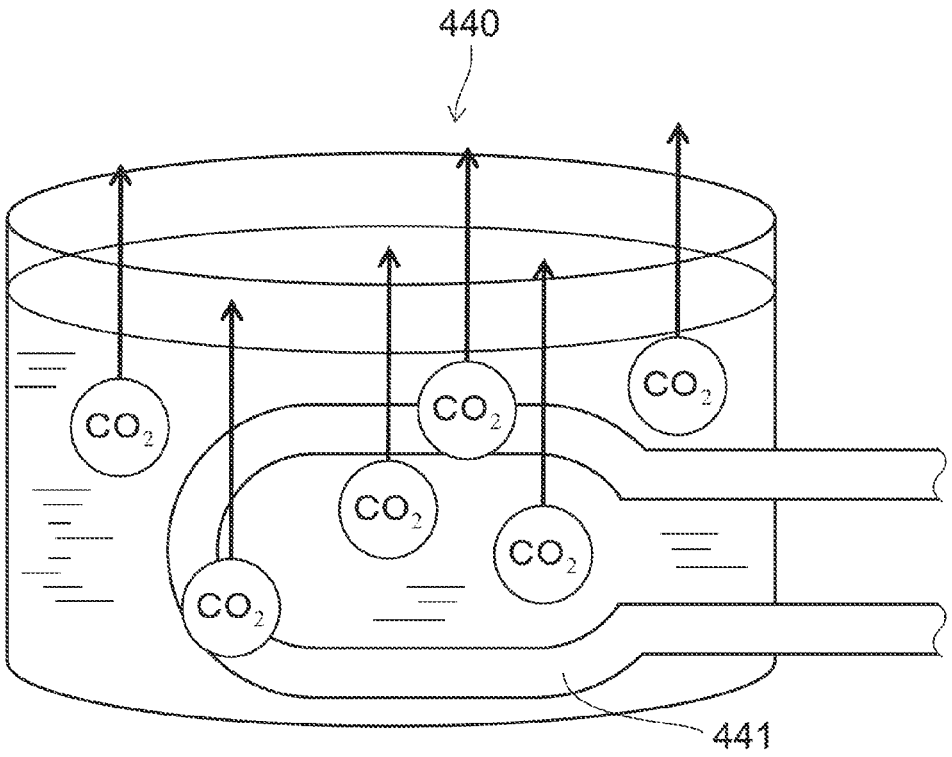


FIG. 7

COMPOUND	UNIT / θ /°C	0	10	20	25	30	40	50	60	80	100
$CaCO_3$	g/L	1.34	1.11	0.91	0.82	0.72	0.55	0.43	0.36	0.26	0.20

FIG. 8

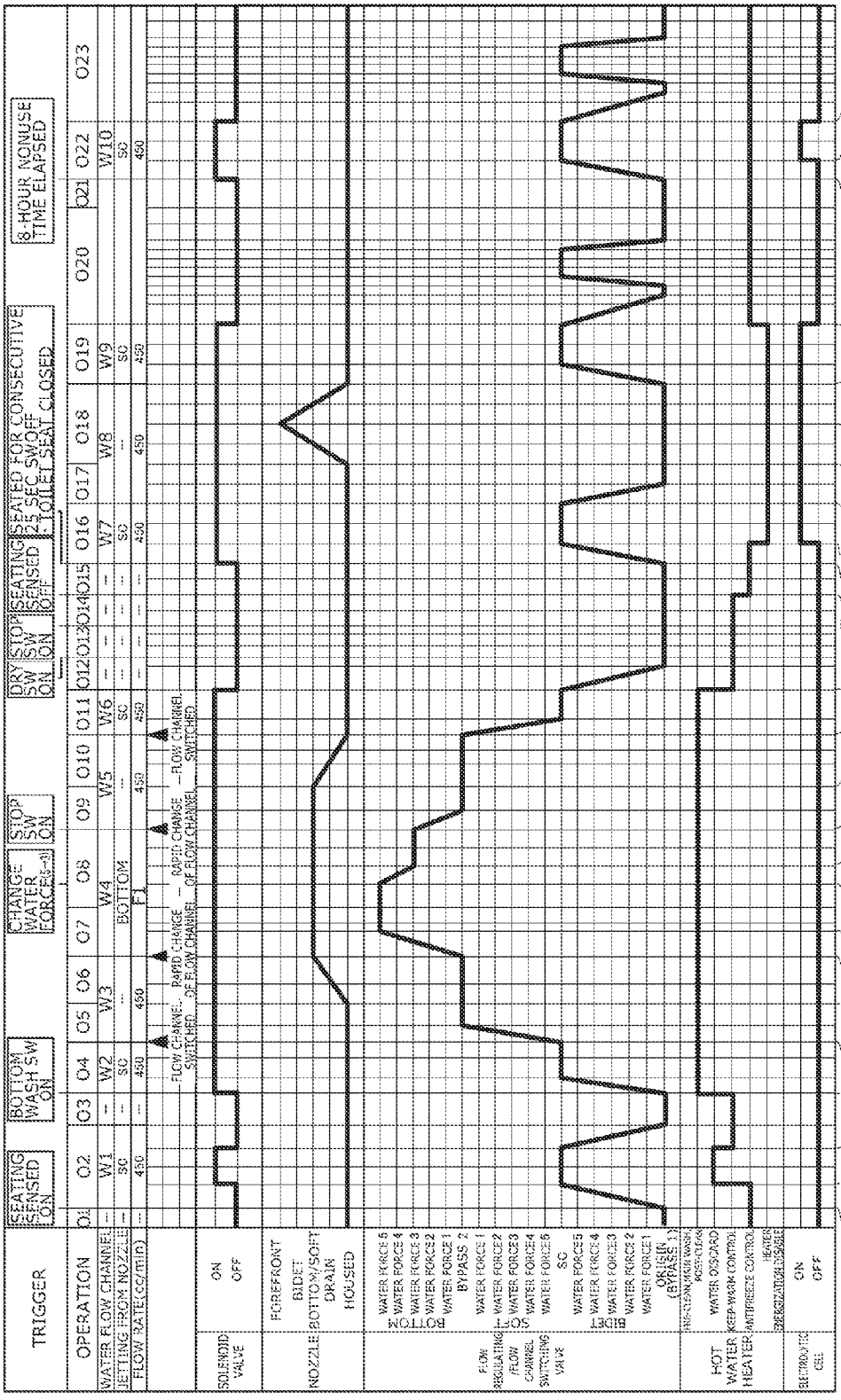

TRIGGER
SEATING SENSED ON
BOTTOM WASH SW ON
CHANGE WATER FORCE(-s)
STOP SW ON
DRY STOP SW ON
SEATING SENSED OFF
SEATED FOR CONSECUTIVE 25 SEC SWOFF TOILET SEAT CLOSED
8-HOUR NONUSE TIME ELAPSED
OPERATION
WATER FLOW CHANNEL
JETTING FROM NOZZLE
FLOW RATE(cc/min)
SOLENOID VALVE
ON
OFF
NOZZLE
FOREFRONT
BIDET
BOTTOM/SOFT
DRAIN
HOUSED
FLOW REGULATING VALVE
WATER FORCE 5
WATER FORCE 4
WATER FORCE 3
WATER FORCE 2
WATER FORCE 1
BYPASS 2
BOTTOM
WATER FORCE 1
WATER FORCE 2
WATER FORCE 3
WATER FORCE 4
WATER FORCE 5
SC
BIDET
WATER FORCE 1
WATER FORCE 2
WATER FORCE 3
WATER FORCE 4
WATER FORCE 5
ORIFICE (BYPASS 1)
HOT WATER HEATER
PRE-CLEAN WASH POSITION
WATER DISCARD
KEEP-WARM CONTROL
ANTIFREEZE CONTROL
HEATER ENERGIZATION/DISABLE
ELECTROLYTIC CELL
ON
OFF
FLOW CHANGE – RAPID CHANGE OF FLOW CHANNEL SWITCHED
FLOW CHANGE – RAPID CHANGE OF FLOW CHANNEL SWITCHED
F1
t201 t202 t203 t204 t205 t206 t207 t208 t209 t210 t211 t212 t213 t214 t215 t216 t217 t218 t219 t220 t221 t222 t223 t224 t225

FIG. 9

SANITARY WASHING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No. 2010-139863, filed on Jun. 18, 2010; the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

An aspect of the invention relates generally to a sanitary washing apparatus, specifically relates to a sanitary washing apparatus for washing such as a "bottom" of a user seated on a sit-down toilet stool with water.

2. Background Art

When a washing nozzle for washing the body, such as the "bottom", of a user seated on a toilet seat squirts wash water at the body, at least part of the washing nozzle is exposed (advanced) outside from the casing installed with prescribed functional components including the washing nozzle and a hot water tank. Hence, dirt and dirty water may be attached to the washing nozzle. In this context, there is a sanitary washing apparatus which cleans away dirt and dirty water attached to the washing nozzle before and/or after body washing. This keeps the washing nozzle clean.

However, in a humid environment such as a toilet room, even after dirt and dirty water attached to the washing nozzle are cleaned away, bacteria may grow on the washing nozzle over time. More specifically, bacteria such as methylobacteria, called pink slime, and black mold grow on the bowl surface of the toilet stool. Such bacteria may be attached to the washing nozzle and multiplied thereon. Multiplication of bacteria results in an aggregation of bacteria and their secretion (slime, black stain), called biofilm, for instance. The biofilm is difficult to remove by the normal nozzle cleaning as mentioned above.

In this context, Japanese Patent No. 3487447 discloses a private part washing apparatus in which an electrolytic cell is incorporated as a nozzle cleaning water producing part. In the private part washing apparatus described in Japanese Patent No. 3487447, when tap water is used as cleaning water, chlorine contained therein is electrolyzed and chemically changed to hypochlorous acid. This can serve as an acidic chemical for cleaning. Hence, effective cleaning can be performed on dirt such as resulting from ammonia in particular.

Here, to efficiently use the cleaning water produced in the electrolytic cell, it is more preferable that the electrolytic cell be provided closer to the nozzle. Thus, JP-A-2005-155098 discloses a private part washing apparatus in which an electrolytic cell is provided on the flow channel on the downstream side of the hot water tank. In the private part washing apparatus described in JP-A-2005-155098, hot water in the electrolytic cell is electrolyzed into electrolytic water. The nozzle cleaning means squirts the hot water as cleaning water at the bottom washing nozzle and the bidet washing nozzle.

However, electrolysis of hot water into electrolytic water is likely to result in producing e.g. calcium carbonate, known as "scale". Scale attached to the electrode of the electrolytic cell causes the problem of decreased production capacity of electrolytic water.

In this context, in order to remove scale, the private part washing apparatus described in JP-A-2005-155098 inverts the polarity of voltage applied to the electrode. Likewise, JP-A-10-034156 discloses an electrolytic cell control apparatus including a polarity switching means for switching the polarity of the anode side and the cathode side of the electrodes of the electrolytic cell. In the private part washing apparatus and the electrolytic cell control apparatus described in JP-A-2005-155098 and JP-A-10-034156, respectively, the produced scale is detached from the surface of the electrode by polarity inversion.

However, if a large amount of scale is produced before performing polarity inversion, in a sanitary washing apparatus with a relatively narrow flow channel, the flow channel may be clogged with scale detached from the electrode. Furthermore, after private part washing, even if heating means such as a hot water tank is not in operation, the flow channel and the electrolytic cell are filled with hot water for the private part washing. Thus, scale is produced even after private part washing, and the amount of the scale may become larger. On the other hand, if polarity inversion is performed frequently, the problem is that the electrode of the electrolytic cell is degraded earlier, and the lifetime of the electrode becomes shorter.

SUMMARY OF THE INVENTION

According to an aspect of the invention, there is provided a sanitary washing apparatus including: a nozzle including a jetting port and configured to squirt water from the jetting port to wash a user's body; a flow channel configured to guide water supplied from a water supply source to the jetting port; an electrolytic cell provided midway along the flow channel and being operable to produce sterilizing water; a heating device provided on the flow channel on upstream side of the electrolytic cell; a nozzle cleaning device configured to clean or sterilize the nozzle with the water heated by the heating device or the sterilizing water produced by the electrolytic cell; and a controller configured to perform control for stopping energization of the heating device or reducing an amount of energization of the heating device when energizing the electrolytic cell.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective schematic view showing a toilet apparatus equipped with a sanitary washing apparatus according to an embodiment of the invention;

FIG. **2** is a block diagram showing the main configuration of the sanitary washing apparatus according to the embodiment;

FIG. **3** is a perspective schematic view illustrating a specific example of the nozzle unit of the embodiment;

FIG. **4** is a conceptual schematic diagram generally showing the operation and the state of the flow channel of the sanitary washing apparatus according to the embodiment;

FIG. **5** is a plan schematic view for describing scale produced in the electrolytic cell unit of the embodiment;

FIG. **6** is a graph showing the variation of the amount of dissolution of calcium carbonate and carbonate ions in response to the variation of pH;

FIG. **7** is a plan schematic view for describing scale produced in the heat exchanger unit of the embodiment;

FIG. **8** is a view showing the variation of the amount of dissolution of calcium carbonate in response to temperature variation; and

FIG. **9** is a tinning chart illustrating a specific example operation of the sanitary washing apparatus according to the embodiment.

DETAILED DESCRIPTION

The first invention is a sanitary washing apparatus including: a nozzle including a jetting port and configured to squirt

water from the jetting port to wash a user's body; a flow channel configured to guide water supplied from a water supply source to the jetting port; an electrolytic cell provided midway along the flow channel and being operable to produce sterilizing water; a heating device provided on the flow channel on upstream side of the electrolytic cell; a nozzle cleaning device configured to clean or sterilize the nozzle with the water heated by the heating device or the sterilizing water produced by the electrolytic cell; and a controller configured to perform control for stopping energization of the heating device or reducing an amount of energization of the heating device when energizing the electrolytic cell.

In this sanitary washing apparatus, when starting energization of the electrolytic cell and causing the electrolytic cell to produce sterilizing water to sterilize the nozzle, energization of the heating device is stopped, or the amount of energization of the heating device is reduced. Hence, when the controller starts energizing the electrolytic cell, water in the electrolytic cell is unheated water. Thus, increase of production of scale can be suppressed.

The second invention is the sanitary washing apparatus according to the first invention, wherein the amount of energization reduced is an amount of energization such that temperature of water heated by the heating device is lower than a preset value of temperature of water for washing the body.

In this sanitary washing apparatus, the controller reduces the amount of energization of the heating device to an amount of energization such that the temperature of water heated by the heating device is lower than the preset value of the temperature of hot water for body washing. Here, even when the controller has reduced the amount of energization of the heating device, if the water temperature falls below a prescribed temperature (e.g. approximately 6° C.), the controller may energize the heating device (turn on/off the heating device) to increase the water temperature in order to prevent water in e.g. the flow channel and the electrolytic cell from freezing. Also in this case, the amount of energization for antifreeze is an amount of energization such that the temperature of water heated by the heating device is lower than the preset value of the temperature of hot water for body washing. Thus, also in this case, increase of production of scale can be suppressed.

Furthermore, after the user leaves the toilet seat or the toilet room, for instance, sterilization is not performed at the temperature of water for washing the body of the next user. The controller reduces the amount of energization of the heating device to an amount of energization such that the temperature of water heated by the heating device is lower than the preset value of the temperature of hot water for body washing. Hence, the nozzle can be sterilized with sterilizing water at a temperature lower than the preset value of the temperature of water for body washing. Thus, increase of production of scale can be suppressed.

The third invention is the sanitary washing apparatus according to the first invention, wherein when energizing the electrolytic cell, if water heated by the heating device exists in the electrolytic cell, the controller starts energizing the electrolytic cell after the heated water in the electrolytic cell is replaced by unheated water.

In this sanitary washing apparatus, when energizing the electrolytic cell, if water heated by the heating device exists in the electrolytic cell, the controller starts energizing the electrolytic cell after replacing the heated water in the electrolytic cell by unheated water. Hence, when the controller starts energizing the electrolytic cell, the hot water in the electrolytic cell has been replaced by unheated water. This can further suppress electrolysis of water heated by the heating device in the electrolytic cell. Increase of production of scale can be suppressed.

The fourth invention is the sanitary washing apparatus according to the first invention, further including: a human body sensing device configured to sense utilization by the user, the controller causing the electrolytic cell to be energized and the nozzle to be sterilized with the sterilizing water after the human body sensing device comes to sense no utilization by the user.

In this sanitary washing apparatus, the controller causes the electrolytic cell to be energized and causes the nozzle to be sterilized with sterilizing water after the human body sensing device comes to sense no utilization by the user. Hence, there is no need to take utilization of body washing by the user into consideration. There is no need to retain hot water in the flow channel. Thus, the controller can cause sterilizing water to be produced in the state in which energization of the heating device is stopped.

The fifth invention is the sanitary washing apparatus according to the fourth invention, wherein the controller causes the electrolytic cell to be energized and the nozzle to be sterilized with the sterilizing water after a prescribed time after the human body sensing device comes to sense no utilization by the user.

In consideration of the case of using the sanitary washing apparatus immediately after the user leaves the toilet seat, hot water heated by the heating device may be left in the flow channel. Also in this case, in this sanitary washing apparatus, the electrolytic cell is energized and the nozzle is sterilized with sterilizing water after a prescribed time after the human body sensing device comes to sense no utilization by the user. Hence, the controller can cause the nozzle to be sterilized after the user definitely leaves the toilet seat.

The sixth invention is the sanitary washing apparatus according to the first invention, wherein the sterilizing water is water containing hypochlorous acid.

The sterilizing water produced by the electrolytic cell can include a solution containing metal ions such as silver ions or copper ions, and a solution containing e.g. electrolytic chlorine or ozone. Among them, a solution containing hypochlorous acid has stronger sterilizing power. Hence, in this sanitary washing apparatus, the nozzle can be sterilized with a solution containing hypochlorous acid, which has stronger sterilizing power.

The seventh invention is the sanitary washing apparatus according to the first invention, further including: a sterilizing water jetting nozzle provided on the flow channel on downstream side of the electrolytic cell and configured to jet the sterilizing water to a surface of a bowl of a toilet stool.

In this sanitary washing apparatus, a sterilizing water jetting nozzle for jetting sterilizing water to the surface of the bowl of the toilet stool is provided independent of the nozzle for washing the body. In general, the sanitary washing apparatus is placed and used on the toilet stool. Hence, the sanitary washing apparatus according to the invention can be effectively used as an apparatus for sterilizing bacteria present on the surface of the bowl of the toilet stool.

Embodiments of the invention will now be described with reference to the drawings. In the drawings, similar components are labeled with like reference numerals, and the detailed description thereof is omitted as appropriate.

FIG. **1** is a perspective schematic view showing a toilet apparatus equipped with a sanitary washing apparatus according to an embodiment of the invention.

FIG. **2** is a block diagram showing the main configuration of the sanitary washing apparatus according to the embodi-

ment. In FIG. **2**, the main configurations of the water channel system and the electrical system are shown together.

The toilet apparatus shown in FIG. **1** includes a sit-down toilet stool (hereinafter simply referred to as "toilet stool" for convenience of description) **800** and a sanitary washing apparatus **100** provided thereon. The sanitary washing apparatus **100** includes a casing **400**, a toilet seat **200**, and a toilet lid **300**. The toilet seat **200** and the toilet lid **300** are each pivotally supported on the casing **400** in an openable/closable manner.

The casing **400** includes therein e.g. a body washing functional part for washing e.g. the "bottom" of a user seated on the toilet seat **200**. Furthermore, for instance, the casing **400** includes a seating sensor (human body sensing device) **404** for sensing seating of a user on the toilet seat **200**. When the seating sensor **404** is sensing a user seated on the toilet seat **200**, the user can manipulate a manipulator **500** such as a remote control to advance a washing nozzle (hereinafter simply referred to as "nozzle" for convenience of description) **473** into the bowl **801** of the toilet stool **800**. In the sanitary washing apparatus **100** shown in FIG. **1**, the nozzle **473** is shown as being advanced into the bowl **801**.

One or more jetting ports **474** are provided at the tip of the nozzle **473**. The nozzle **473** can squirt water from the jetting port **474** provided at its tip to wash e.g. the "bottom" of the user seated on the toilet seat **200**.

More specifically, as shown in FIG. **2**, the sanitary washing apparatus **100** according to the embodiment includes a flow channel **20** for guiding water supplied from a water supply source **10** such as a water tap or a flush tank to the jetting port **474** of the nozzle **473**. A solenoid valve **431** is provided on the upstream side of the flow channel **20**. The solenoid valve **431** is an openable/closable solenoid valve, and regulates water supply based on commands from a controller **405** provided inside the casing **400**. Here, the flow channel **20** refers to the downstream side or secondary side of the solenoid valve **431**.

A heat exchanger unit (heating device) **440** is provided downstream of the solenoid valve **431**. The heat exchanger unit **440** includes a hot water heater **441**. The hot water heater **441** heats supplied water to hot water at a prescribed temperature. On the upstream side of the hot water heater **441** is provided an incoming water thermistor, not shown. On the downstream side of the hot water heater **441** is provided a hot water thermistor, not shown. The hot water temperature can be configured by e.g. the user manipulating the manipulator **500**.

An electrolytic cell unit (electrolytic cell) **450** operable to produce sterilizing water is provided downstream of the hot water heater **441**. The nozzle **473** and the flow channel **20** on the downstream side of the electrolytic cell unit **450** are sterilized with sterilizing water produced in the electrolytic cell unit **450**. The electrolytic cell unit **450** is described later in detail.

A pressure modulator **460** is provided downstream of the electrolytic cell unit **450**. This pressure modulator **460** provides pulsation to the flow of water in the flow channel **20**. Thus, the pressure modulator **460** can provide pulsation to the water jetted from the jetting port **474** of the nozzle **473**. However, in the invention, the pressure modulator **460** is not necessarily needed.

A flow rate switching valve **471** for adjusting the water force (flow rate), and a flow channel switching valve **472** for opening/closing and switching water supply to the nozzle **473** and a nozzle cleaning chamber (nozzle cleaning device) **478**, are provided downstream of the pressure modulator **460**. Here, the flow rate switching valve **471** and the flow channel switching valve **472** may be provided as a single unit. Furthermore, a nozzle **473** is provided downstream of the flow rate switching valve **471** and the flow channel switching valve **472**.

As described above, the nozzle **473** can squirt water to wash e.g. the "bottom" of a user seated on the toilet seat **200**. On the other hand, a sterilizing water jetting nozzle may be provided independent of the nozzle **473**. By the sterilizing water jetting nozzle, sterilizing water produced in the electrolytic cell unit **450** is jetted from the flow channel switching valve **472** to the surface of the bowl **801** of the toilet stool **800**. In this case, the sterilizing water jetting nozzle, not shown, is provided on the flow channel **20** on the downstream side of the electrolytic cell unit **450**. In general, the sanitary washing apparatus **100** is placed and used on the toilet stool **800**. Hence, in the case where the sterilizing water jetting nozzle for jetting sterilizing water to the surface of the bowl **801** is provided, the sanitary washing apparatus **100** can be effectively used also as an apparatus for sterilizing bacteria present on the surface of the bowl **801** of the toilet stool **800**.

The nozzle **473** can be advanced into or retracted from the bowl **801** of the toilet stool **800** under a driving force from a nozzle motor **476**. That is, the nozzle motor **476** can advance/retract the nozzle **473** based on commands from the controller **405**.

Furthermore, the controller **405** is supplied with electrical power from a power supply circuit **401**. The controller **405** can receive signals from a room entry sensor (human body sensing device) **402** for sensing entry of a user into the toilet room, a human body sensor (human body sensing device) **403** for sensing a user present in front of the toilet seat **200**, a seating sensor **404** for sensing seating of a user on the toilet seat **200**, and a manipulator **500**. Based on these signals, the controller **405** can control the operation of the solenoid valve **431**, hot water heater **441**, electrolytic cell unit **450**, flow rate switching valve **471** and flow channel switching valve **472**, and nozzle motor **476**.

The seating sensor **404** can sense a human body present above the toilet seat **200** immediately before the user is seated on the toilet seat **200**. Furthermore, the seating sensor **404** can sense a user seated on the toilet seat **200**. That is, the seating sensor **404** can sense not only a user seated on the toilet seat **200**, but also a user present above the toilet seat **200**. Such a seating sensor **404** can be e.g. an infrared transmit/receive range sensor.

The human body sensor **403** can sense a user present in front of the toilet stool **800**, i.e., a user present at a position spaced in front of the toilet seat **200**. That is, the human body sensor **403** can sense a user entering the toilet room and approaching the toilet seat **200**. Such a human body sensor **403** can be e.g. an infrared transmit/receive range sensor.

The room entry sensor **402** can sense a user who has just opened the door of the toilet room and entered the toilet room. Furthermore, the room entry sensor **402** can sense a user about to enter the toilet room and present in front of the door. That is, the room entry sensor **402** can sense not only a user who has entered the toilet room, but also a user who is yet to enter the toilet room, i.e., a user present in front of the door outside the toilet room. Such a room entry sensor **402** can be e.g. a pyroelectric sensor, or a microwave sensor such as Doppler sensor. The microwave sensor can be based on the microwave Doppler effect, or can transmit a microwave and detect an object based on the amplitude (intensity) of the reflected microwave. In the case of using such a sensor, the presence of a user can be sensed beyond the door of the toilet room. That is, such a sensor can sense a user before entering the toilet room.

In the toilet apparatus shown in FIG. **1**, a recess **409** is formed in the upper surface of the casing **400**. The room entry sensor **402** is partly embedded in this recess **409**. In the closed state of the toilet lid **300**, the room entry sensor **402** senses entry of a user through a transmissive window **310** provided near the base of the toilet lid **300**. For instance, when the room entry sensor **402** senses a user, the controller **405** can automatically open the toilet lid **300** based on the sensing result of the room entry sensor **402**. Furthermore, the seating sensor **404** and the human body sensor **403** are provided at the front center of the casing **400**. However, the installation configuration of the seating sensor **404**, the human body sensor **403**, and the room entry sensor **402** is not limited thereto, but can be suitably modified.

The casing **400** may further include various mechanisms as appropriate, such as a "warm air drying function" for blowing warm air at and drying e.g. the "bottom" of the user seated on the toilet seat **200**, a "deodorizing unit", and a "room heating unit". In this case, an exhaust port **407** for exhaust from the deodorizing unit and a vent **408** for exhaust from the room heating unit are provided as appropriate on the side surface of the casing **400**. However, in the invention, the sanitary washing functional part and other added functional parts are not necessarily needed.

FIG. **3** is a perspective schematic view illustrating a specific example of the nozzle unit of the embodiment.

As shown in FIG. **3**, the nozzle unit **470** of the embodiment includes a mounting stage **475** as a base stage, a nozzle **473** supported on the mounting stage **475**, and a nozzle motor **476** for moving the nozzle **473**. The nozzle **473** is provided so as to be slidable with respect to the mounting stage **475**, as indicated by arrow A shown in FIG. **3**, by the driving force transmitted from the nozzle motor **476** through a transmission member **477** such as a belt. That is, the nozzle **473** can linearly move in its own axial direction (advancing/retracting direction). The nozzle **473** can reciprocably move from the casing **400** and the mounting stage **475**.

Furthermore, the nozzle unit **470** of the embodiment includes a nozzle cleaning chamber **478**. The nozzle cleaning chamber **478** is fixed to the mounting stage **475**. The nozzle cleaning chamber **478** can sterilize or clean the outer peripheral surface (trunk) of the nozzle **473** by squirting sterilizing water or water from a jetting portion **479** provided inside the nozzle cleaning chamber **478**. Specifically, when the controller **405** causes the anode plate **454** (see FIG. **5**) and the cathode plate **455** (see FIG. **5**) of the electrolytic cell unit **450** to be energized to produce sterilizing water, the trunk of the nozzle **473** is sterilized with sterilizing water squirted from the jetting portion **479**. On the other hand, when the controller **405** does not cause the anode plate **454** and the cathode plate **455** of the electrolytic cell unit **450** to be energized, the trunk of the nozzle **473** is physically cleaned with water squirted from the jetting portion **479**.

More specifically, with the nozzle **473** housed in the casing **400**, the region of the jetting ports **474** of the nozzle **473** is substantially housed in the nozzle cleaning chamber **478**. Hence, the nozzle cleaning chamber **478** can sterilize or clean the region of the jetting ports **474** of the nozzle **473** in the housed state by squirting sterilizing water or water from the jetting portion **479** provided inside the nozzle cleaning chamber **478**. Furthermore, the nozzle cleaning chamber **478** can sterilize or clean not only the region of the jetting ports **474** but also the outer peripheral surface of the other region by squirting water or sterilizing water from the jetting portion **479** when the nozzle **473** is advanced/retracted.

Furthermore, with the nozzle **473** housed in the casing **400**, the nozzle **473** of the embodiment can sterilize or clean the region of the jetting ports **474** by jetting sterilizing water or water from the jetting ports **474** of the nozzle **473** themselves. Furthermore, with the nozzle **473** housed in the casing **400**, the region of the jetting ports **474** of the nozzle **473** is substantially housed in the nozzle cleaning chamber **478**. Hence, the sterilizing water or water jetted from the jetting port **474** of the nozzle **473** is reflected by the inner wall of the nozzle cleaning chamber **478** and splashed on the region of the jetting ports **474**. Thus, the region of the jetting ports **474** of the nozzle **473** is sterilized or cleaned also with the sterilizing water or water reflected by the inner wall of the nozzle cleaning chamber **478**.

FIG. **4** is a conceptual schematic diagram generally showing the operation and the state of the flow channel of the sanitary washing apparatus according to the embodiment.

The state of the flow channel shown in FIG. **4** shows the state inside the flow channel **20** on the downstream side of the electrolytic cell unit **450**.

As described later with reference to FIG. **5**, under energization controlled by the controller **405**, the electrolytic cell unit **450** can electrolyze tap water flowing in the gap (flow channel) between the anode plate **454** and the cathode plate **455**. The water electrolyzed in the electrolytic cell unit **450** turns into a liquid containing hypochlorous acid.

Here, the sterilizing water produced in the electrolytic cell unit **450** may be a solution containing metal ions such as silver ions or copper ions. Alternatively, the sterilizing water produced in the electrolytic cell unit **450** may be a solution containing electrolytic chlorine or ozone. Alternatively, the sterilizing water produced in the electrolytic cell unit **450** may be acid water or alkaline water. Among them, a solution containing hypochlorous acid has stronger sterilizing power. In the following description, by way of example, it is assumed that the sterilizing water produced in the electrolytic cell unit **450** is a solution containing hypochlorous acid.

Hypochlorous acid functions as a sterilizing ingredient. A solution containing hypochlorous acid, i.e., sterilizing water, can efficiently remove or decompose and sterilize dirt such as resulting from ammonia. Here, the term "sterilizing water" used herein refers to a solution containing a sterilizing ingredient such as hypochlorous acid more than tap water (also simply referred to as "water").

When the electrolytic cell unit **450** electrolyzes tap water to produce a solution containing hypochlorous acid, i.e., sterilizing water, scale such as calcium carbonate ($CaCO_3$) is produced. Scale is produced when, for instance, calcium ions (Ca^{2+}) dissolved in water are combined with carbonate ions (CO_3^{2-}) produced from carbonic acid (H_2CO_3). If scale is produced and attached to the surface of the anode plate **454** and the cathode plate **455** of the electrolytic cell unit **450**, the production efficiency of hypochlorous acid may decrease.

As a result of investigation, the inventors have found that as the temperature of water electrolyzed becomes higher, scale becomes more likely to be produced. Furthermore, as a result of investigation, the inventors have found that as the pH (hydrogen ion concentration) of water electrolyzed becomes higher, scale becomes more likely to be produced. These will be described later in detail.

Thus, in the embodiment, when energizing the electrolytic cell unit **450**, the controller **405** performs control for stopping energizing the hot water heater **441** or reducing the amount of energization of the hot water heater **441**. The operation of the sanitary washing apparatus **100** according to the embodiment is outlined with reference to FIG. **4**.

First, when the seating sensor **404** senses a user seated on the toilet seat **200**, the controller **405** opens the solenoid valve **431** and causes it to supply clean water to the flow channel **20**

(timing t101). At this time, the sanitary washing apparatus 100 activates the hot water heater 441. Thus, water in the flow channel 20 is drained to the bowl 801 of the toilet stool 800 and replaced by hot water heated by the hot water heater 441. That is, the controller 405 starts hot water preparation for activating the hot water heater 441 and draining water from the jetting port 474 (timing t101). Here, the time period for performing the hot water preparation is e.g. approximately 6-15 seconds. The term "clean water" used herein refers not only to cold water, but also to heated hot water.

Next, when the user presses the "bottom washing switch", not shown, provided on the manipulator 500 (timing t102), the controller 405 receives a signal for performing body washing. Then, the controller 405 first performs "pre-cleaning" with clean water (timing t102-t103). More specifically, the controller 405 controls the flow rate switching valve 471 and the flow channel switching valve 472 so that clean water is jetted from all the plurality of jetting ports 474 to clean these jetting ports 474. At this time, the controller 405 does not cause the electrolytic cell unit 450 to be energized, and does not cause it to produce sterilizing water. Hence, the region of the plurality of jetting ports 474 is physically cleaned with clean water jetted by the jetting ports 474 themselves (including clean water reflected by the inner wall of the nozzle cleaning chamber 478). Here, the time period for performing the pre-cleaning is e.g. approximately 2-7 seconds.

Next, the controller 405 controls the flow rate switching valve 471 and the flow channel switching valve 472 so that clean water is squirted from the jetting portion 479 provided in the nozzle cleaning chamber 478. Simultaneously, the controller 405 advances the nozzle 473 into the bowl 801. Thus, the trunk of the nozzle 473 is cleaned with clean water squirted from the jetting portion 479 (timing t103-t104). At this time again, the controller 405 does not energize the electrolytic cell unit 450, and does not cause it to produce sterilizing water. Hence, the trunk of the nozzle 473 is physically cleaned with clean water squirted from the jetting portion 479. Here, the time period for advancing the nozzle 473 is e.g. approximately 1.2-2.5 seconds.

Next, the controller 405 controls the flow rate switching valve 471 and the flow channel switching valve 472 so that clean water is squirted from the jetting port 474 for "bottom washing" to wash the "bottom" of the user seated on the toilet seat 200 (timing t104-t105). At this time, the controller 405 does not energize the electrolytic cell unit 450, and does not cause it to produce sterilizing water. Hence, there is no case where sterilizing water is squirted at the user's body. Furthermore, because the hot water heater 441 is in operation, the user's body is washed with hot water heated by the hot water heater 441.

Next, when the user presses the "stop switch", not shown, on the manipulator 500 (timing U05), the controller 405 performs control for depressurization (timing t105-t106). Then, the controller 405 controls the flow rate switching valve 471 and the flow channel switching valve 472 so that clean water is squirted from the jetting portion 479 provided in the nozzle cleaning chamber 478. Simultaneously, the controller 405 houses the nozzle 473 in the casing 400 (timing t106-t107). That is, similarly to the time of advancing the nozzle, the controller 405 causes the trunk of the nozzle 473 to be physically cleaned with clean water squirted from the jetting portion 479. Here, the time period for housing the nozzle 473 is e.g. approximately 1.2-2.5 seconds.

Next, with the nozzle 473 housed in the casing 400, the controller 405 controls the flow rate switching valve 471 and the flow channel switching valve 472 so that clean water is jetted from all the plurality of jetting ports 474 to perform "post-cleaning" of these jetting ports 474 (timing t107-t108). At this time, the controller 405 does not energize the electrolytic cell unit 450, and does not cause it to produce sterilizing water. Hence, the region of the plurality of jetting ports 474 is physically cleaned with clean water jetted by the jetting ports 474 themselves (including clean water reflected by the inner wall of the nozzle cleaning chamber 478). Here, the time period for performing the post-cleaning is e.g. approximately 3 seconds.

Next, when a prescribed time (here e.g. approximately 25 seconds) has elapsed after the seating sensor 404 comes not to sense the user seated on the toilet seat 200, the controller 405 starts energizing the electrolytic cell unit 450 and causes the electrolytic cell unit 450 to produce sterilizing water (timing t109). Furthermore, the controller 405 stops energizing the hot water heater 441 or reduces the amount of energization of the hot water heater 441 (timing t109). Here, the term "reduce the amount of energization" refers to reduction to an amount of energization such that the temperature of water heated by the hot water heater 441 is lower than a preset value of the temperature of hot water for body washing. Here, the preset value of the temperature of hot water for body washing is e.g. approximately 30-40° C.

If hot water exists in the electrolytic cell unit 450 when the controller 405 starts energizing the electrolytic cell unit 450, the controller 405 opens the solenoid valve 431. Thus, the hot water in the electrolytic cell unit 450 is drained and replaced by unheated water. Then, the controller 405 starts energizing the electrolytic cell unit 450.

Furthermore, the controller 405 opens the solenoid valve 431 to supply sterilizing water to the flow channel 20 on the downstream side of the electrolytic cell unit 450 (timing t109). Thus, the flow channel 20 on the downstream side of the electrolytic cell unit 450 is sterilized with sterilizing water. Furthermore, the controller 405 controls the flow rate switching valve 471 and the flow channel switching valve 472 so that sterilizing water is jetted from all the plurality of jetting ports 474 to perform "pre-sterilization" of these jetting ports 474 (timing t109-t110). Hence, the region of the plurality of jetting ports 474 is sterilized with sterilizing water jetted by the jetting ports 474 themselves (including sterilizing water reflected by the inner wall of the nozzle cleaning chamber 478). Here, the time period for performing the pre-sterilization is e.g. approximately 3 seconds.

Next, the controller 405 controls the flow rate switching valve 471 and the flow channel switching valve 472 so that sterilizing water is squirted from the jetting portion 479 provided in the nozzle cleaning chamber 478. Simultaneously, the controller 405 advances the nozzle 473 into the bowl 801, and then houses it in the casing 400 (timing t110-t111). That is, the controller 405 performs "trunk cleaning" of the nozzle 473 with sterilizing water squirted from the jetting portion 479 (timing t110-t111). Thus, the inside of the flow channel 20 on the downstream side of the electrolytic cell unit 450 and the trunk of the nozzle 473 are sterilized with sterilizing water. Here, the time period for performing the trunk cleaning with sterilizing water is e.g. approximately 5 seconds.

Next, with the nozzle 473 housed in the casing 400, the controller 405 controls the flow rate switching valve 471 and the flow channel switching valve 472 so that sterilizing water is jetted from all the plurality of jetting ports 474 to perform "post-sterilization" of these jetting ports 474 (timing t111-t112). Hence, the region of the plurality of jetting ports 474 is sterilized with sterilizing water jetted by the jetting ports 474 themselves (including sterilizing water reflected by the inner

wall of the nozzle cleaning chamber **478**). Here, the time period for performing the post-sterilization is e.g. approximately 3 seconds.

Next, the controller **405** closes the solenoid valve **431**, and then closes the flow channel switching valve **472**, so that the sterilizing water produced in the electrolytic cell unit **450** is retained for a prescribed time inside the flow channel **20** (timing t**112**-t**113**). Thus, after the user performs "bottom washing", the inside of the flow channel **20** can be sterilized. This prescribed time is e.g. approximately 60 minutes. Thus, in the sanitary washing apparatus **100** according to the embodiment, the sterilizing water is retained for a longer time inside the flow channel **20**. Hence, bacteria surviving inside the flow channel **20** can be sterilized more reliably.

Next, after the lapse of the prescribed time, the controller **405** performs "drainage" (timing t**113**-t**114**). That is, the controller **405** drains the sterilizing water inside the flow channel **20** so that the flow channel **20** is emptied. The time period for performing this "drainage" is e.g. approximately 30 seconds. Thus, in the sanitary washing apparatus **100** according to the embodiment, after the sterilizing water is retained for a prescribed time inside the flow channel **20**, the sterilizing water inside the flow channel **20** is drained, and the flow channel **20** is emptied. Hence, even if the sterilizing power of the sterilizing water is decreased over time, the action of the sterilizing water as a nutrient source for bacteria can be suppressed.

Next, similarly to the operation described above with reference to timing t**112**-t**113**, the controller **405** causes the sterilizing water produced in the electrolytic cell unit **450** to be retained for a prescribed time inside the flow channel **20** (timing t**114**-t**115**).

Next, when a prescribed time (here e.g. approximately 8 hours) has elapsed after the last use of the sanitary washing apparatus **100**, the controller **405** performs "pre-sterilization" and "post-sterilization" (timing t**115**-t**116** and timing t**116**-t**117**) similarly to the operation described above with reference to timing t**109**-t**110** and timing t**111**-t**112**.

According to the embodiment, the controller **405** stops energizing the hot water heater **441** or reduces the amount of energization of the hot water heater **441** when the controller **405** starts energizing the electrolytic cell unit **450** and causes the electrolytic cell unit **450** to produce sterilizing water to sterilize the nozzle **473**. Hence, when the controller **405** starts energizing the electrolytic cell unit **450**, the water in the electrolytic cell unit **450** is unheated water. Alternatively, if hot water exists in the electrolytic cell unit **450** when the controller **405** starts energizing the electrolytic cell unit **450**, the controller **405** opens the solenoid valve **431**. Thus, the hot water in the electrolytic cell unit **450** is drained and replaced by unheated water. Then, the controller **405** starts energizing the electrolytic cell unit **450**. Hence, when the controller **405** starts energizing the electrolytic cell unit **450**, the hot water in the electrolytic cell unit **450** is replaced by unheated water. Thus, increase of production of scale can be suppressed.

Even when the controller **405** has reduced the amount of energization of the hot water heater **441**, if the water temperature falls below a prescribed temperature (e.g. approximately 6° C.), the controller **405** may energize the hot water heater **441** (turn on/off the hot water heater **441**) to increase the water temperature in order to prevent water in e.g. the flow channel **20** and the electrolytic cell unit **450** from freezing. Also in this case, the amount of energization for antifreeze is an amount of energization such that the temperature of water heated by the hot water heater **441** is lower than the preset value of the temperature of hot water for body washing. Thus, also in this case, increase of production of scale can be suppressed. That is, the scope of the term "reduce the amount of energization" used herein encompasses the case of "energize the hot water heater **441** on the occasion of antifreeze".

Furthermore, after the user leaves the toilet seat **200** or the toilet room, for instance, sterilization is not performed at the temperature of water for washing the body of the next user. The controller **405** reduces the amount of energization of the hot water heater **441** to an amount of energization such that the temperature of water heated by the hot water heater **441** is lower than the preset value of the temperature of hot water for body washing. Hence, the nozzle **473** can be sterilized with sterilizing water at a temperature lower than the preset value of the temperature of water for body washing. Thus, increase of production of scale can be suppressed.

Furthermore, the controller **405** starts energizing the electrolytic cell unit **450** and causes the electrolytic cell unit **450** to produce sterilizing water after the seating sensor **404** comes not to sense the user seated on the toilet seat **200**. Hence, there is no need to take utilization of body washing by the user into consideration. There is no need to retain hot water in the flow channel **20**. Thus, the controller **405** can cause sterilizing water to be produced in the state in which energization of the hot water heater **441** is stopped.

In consideration of the case of using the sanitary washing apparatus **100** immediately after the user leaves the toilet seat **200**, hot water heated by the hot water heater **441** may be left in the flow channel **20**. Also in this case, in the embodiment, the controller **405** starts energizing the electrolytic cell unit **450** and causes the electrolytic cell unit **450** to produce sterilizing water after the lapse of a prescribed time after the seating sensor **404** comes not to sense the user seated on the toilet seat **200**. Hence, the controller **405** can cause the nozzle **473** to be sterilized after the user definitely leaves the toilet seat **200**.

In the foregoing, the operation shown in FIG. **4** is described by taking an example in which the nozzle **473** is sterilized with sterilizing water after the seating sensor **404** comes not to sense the user seated on the toilet seat **200**. However, the embodiment is not limited thereto. The controller **405** may cause the nozzle **473** to be sterilized with sterilizing water after the human body sensor **403** or the room entry sensor **402** comes not to sense the user. Also in this case, the controller **405** can stop energizing the hot water heater **441** or reduce the amount of energization of the hot water heater **441**, and cause the electrolytic cell unit **450** to produce sterilizing water. Thus, increase of production of scale can be suppressed.

FIG. **5** is a plan schematic view for describing scale produced in the electrolytic cell unit of the embodiment.

FIG. **6** is a graph showing the variation of the amount of dissolution of calcium carbonate and carbonate ions in response to the variation of pH.

As shown in FIG. **5**, the electrolytic cell unit **450** includes therein an anode plate **454** and a cathode plate **455**. Under energization controlled by the controller **405**, the electrolytic cell unit **450** can electrolyze tap water flowing in the gap (flow channel) between the anode plate **454** and the cathode plate **455**. Here, at the cathode plate **455**, the reaction represented by formula (1) occurs.

$$H^+ + e^- \rightarrow \frac{1}{2}H_2\uparrow \quad (1)$$

Hence, acid (H^+) is consumed at the cathode plate **455**, and pH increases near the cathode plate **455**. As shown in FIG. **6**, as pH increases, the amount of dissolution of carbonate ions (CO_3^{2-}) increases. With the increase of pH, carbonic acid

(H_2CO_3) releases hydrogen ions (H^+) to produce carbonate ions (CO_3^{2-}). Thus, the reaction represented by formula (2) occurs. Then, the generated carbonate ions (CO_3^{2-}) are combined with calcium ions (Ca^{2+}) present in tap water. Thus, the reaction represented by formula (3) occurs. That is, the increase of pH causes production (precipitation due to decreased solubility) of calcium carbonate ($CaCO_3$, i.e., scale).

$$H_2CO_3 \rightarrow 2H^+ + CO_3^{2-} \quad (2)$$

$$Ca^{2+} + CO_3^{2-} \rightarrow CaCO_3 \quad (3)$$

On the other hand, at the anode plate **454**, the reaction represented by formula (4) occurs. Furthermore, the tap water contains chlorine ions (Cl^-). Such chlorine ions are contained as salt (NaCl) and calcium chloride ($CaCl_2$) in water sources (e.g. groundwater and water in dams and rivers). Thus, the reaction represented by formula (5) occurs.

$$2OH^- \rightarrow 2e^- + H_2O + \frac{1}{2}O_2\uparrow \quad (4)$$

$$Cl^- \rightarrow e^- + \frac{1}{2}Cl_2 \quad (5)$$

Chlorine generated in formula (5) is less likely to exist as bubbles, but mostly dissolves in water. Hence, chlorine generated in formula (5) undergoes the reaction represented by formula (6). Thus, hypochlorous acid (HClO) is produced by electrolysis of chlorine ions. Consequently, the water electrolyzed in the electrolytic cell unit **450** turns into a liquid containing hypochlorous acid. Here, alkali (OH^-) is consumed at the anode plate **454**. Hence, pH decreases near the anode plate **454**.

$$Cl_2 + H_2O \rightarrow HClO + H^+ + Cl^- \quad (6)$$

FIG. **7** is a plan schematic view for describing scale produced in the heat exchanger unit of the embodiment.

FIG. **8** is a view showing the variation of the amount of dissolution of calcium carbonate in response to temperature variation.

For instance, if the controller **405** starts energizing the electrolytic cell unit **450**, the water temperature in the heat exchanger unit **440** increases. Thus, carbonic acid becomes less likely to dissolve in water, and is released as carbon dioxide (CO_2) into the air. Then, pH increases near the hot water heater **441**. Thus, as described above with reference to FIGS. **5** and **6**, scale becomes more likely to be produced. Furthermore, as shown in FIG. **8**, as the water temperature increases, the amount of dissolution of calcium carbonate decreases. That is, as the water temperature increases, calcium carbonate becomes less soluble in water. Thus, as the water temperature increases, scale becomes more likely to be produced and precipitated.

This holds not only in the heat exchanger unit **440**, but also in the electrolytic cell unit **450**. That is, if higher temperature water is supplied to the electrolytic cell unit **450** and electrolyzed in the electrolytic cell unit **450**, scale becomes more likely to be produced and precipitated.

Thus, as the water temperature increases, scale becomes more likely to be produced in the electrolytic cell unit **450** and the heat exchanger unit **440**. Hence, in order to suppress the increase of production of scale and to suppress the decrease of production efficiency of hypochlorous acid, it is necessary to suppress the increase of production of scale in the electrolytic cell unit **450** and the heat exchanger unit **440**.

In this context, according to the embodiment, when the controller **405** starts energizing the electrolytic cell unit **450**, the controller **405** stops energizing the hot water heater **441** or reduces the amount of energization of the hot water heater **441**. Hence, when sterilizing water is produced in the electrolytic cell unit **450**, increase of temperature of water in the electrolytic cell unit **450** and the heat exchanger unit **440** can be suppressed. Thus, the increase of production of scale in the electrolytic cell unit **450** and the heat exchanger unit **440** can be suppressed.

FIG. **9** is a timing chart illustrating a specific example operation of the sanitary washing apparatus according to the embodiment.

"O**1**" of "OPERATION" in FIG. **9** shows "STANDBY". "O**2**" of "OPERATION" in FIG. **9** shows "HOT WATER PREPARATION". "O**3**" of "OPERATION" in FIG. **9** shows "KEEP WARM". "O**4**" of "OPERATION" in FIG. **9** shows "PRE-CLEAN". "O**5**" of "OPERATION" in FIG. **9** shows "DEPRESSURE". "O**6**" of "OPERATION" in FIG. **9** shows "TRUNK CLEAN (ADVANCE NOZZLE)". "O**7**" of "OPERATION" in FIG. **9** shows "SOFT START". "O**8**" of "OPERATION" in FIG. **9** shows "MAIN WASH". "O**9**" of "OPERATION" in FIG. **9** shows "DEPRESSURE". "O**10**" of "OPERATION" in FIG. **9** shows "TRUNK CLEAN (HOUSE NOZZLE)". "O**11**" of "OPERATION" in FIG. **9** shows "POST-CLEAN". "O**12**" of "OPERATION" in FIG. **9** shows "KEEP WARM". "O**13**" of "OPERATION" in FIG. **9** shows "DRY". "O**14**" of "OPERATION" in FIG. **9** shows "KEEP WARM". "O**15**" of "OPERATION" in FIG. **9** shows "STANDBY". "O**16**" of "OPERATION" in FIG. **9** shows "PRE-STERILIZE". "O**17**" of "OPERATION" in FIG. **9** shows "DEPRESSURE". "O**18**" of "OPERATION" in FIG. **9** shows "TRUNK CLEAN (HOUSE NOZZLE)". "O**19**" of "OPERATION" in FIG. **9** shows "POST-STERILIZE". "O**20**" of "OPERATION" in FIG. **9** shows "DRAINAGE/HOT AIR DAMPER STUCK PREVENTION". "O**21**" of "OPERATION" in FIG. **9** shows "STANDBY". "O**22**" of "OPERATION" in FIG. **9** shows "REGULAR STERILIZATION". "O**23**" of "OPERATION" in FIG. **9** shows "DRAINAGE/HOT AIR DAMPER STUCK PREVENTION".

"W**1**" and "W**2**" of "WATER FLOW CHANNEL" in FIG. **9** show "MAIN CHANNEL". "W**3**" of "WATER FLOW CHANNEL" in FIG. **9** shows "BYPASS". "W**4**" of "WATER FLOW CHANNEL" in FIG. **9** shows "MAIN CHANNEL". "W**5**" of "WATER FLOW CHANNEL" in FIG. **9** shows "BYPASS". "W**6**" and "W**7**" of "WATER FLOW CHANNEL" in FIG. **9** show "MAIN CHANNEL". "W**8**" of "WATER FLOW CHANNEL" in FIG. **9** shows "BYPASS". "W**9**" and "W**10**" of "WATER FLOW CHANNEL" in FIG. **9** show "MAIN CHANNEL".

"F**1**" of "FLOW RATE (cc/min)" in FIG. **9** shows "FROM MINIMUM TO PRESET FLOW RATE (**270-430**)".

First, the seating sensor **404** senses a user seated on the toilet seat **200** (timing t**201**). Then, the controller **405** switches the flow rate switching valve **471** and the flow channel switching valve **472** from "origin" to "SC (self-cleaning)" and enables jetting from all the jetting ports **474** for "bottom washing" and "bidet washing". The flow rate (volume of water) at this time is e.g. approximately 450 cc/min.

Next, when the switching of the flow rate switching valve **471** and the flow channel switching valve **472** is completed (timing t**202**), the controller **405** opens the solenoid valve **431** and sets the hot water heater **441** to the "water discard mode". Thus, cold water in the flow channel **20** is drained to perform hot water preparation again. Next, after completing the hot water preparation, the controller **405** closes the solenoid valve **431** and switches the flow rate switching valve **471** and the

flow channel switching valve **472** from "SC" to "origin (bypass **1**)" (timing t**203**). Furthermore, the controller **405** changes the setting of the hot water heater **441** from the "water discard mode" to the "keep-warm control mode" (timing t**203**).

Next, when the user presses the "bottom washing switch", not shown, provided on the manipulator **500** (timing t**204**), the controller **405** receives a signal for performing body washing. Then, the controller **405** switches the flow rate switching valve **471** and the flow channel switching valve **472** from "origin" to "SC". Furthermore, the controller **405** opens the solenoid valve **431** and sets the hot water heater **441** to the "pre-cleaning mode, main washing mode, post-cleaning mode".

At this time, the controller **405** does not cause the electrolytic cell unit **450** to be energized, and does not cause it to produce sterilizing water. Furthermore, the controller **405** has set the hot water heater **441** to the "pre-cleaning mode, main washing mode, post-cleaning mode" and caused it to heat water. Hence, the region of the jetting ports **474** is cleaned with hot water jetted by the jetting ports **474** themselves.

Next, the controller **405** switches the flow rate switching valve **471** and the flow channel switching valve **472** from "SC" to "bypass **2**" so that water can be squirted from the jetting portion **479** provided in the nozzle cleaning chamber **478** (timing t**205**). Next, the controller **405** advances the nozzle **473** housed in the casing **400** to the position of "bottom washing" (timing t**206**-t**207**).

At this time, the controller **405** has opened the solenoid valve **431**, does not cause the electrolytic cell unit **450** to be energized, and does not cause it to produce sterilizing water. Furthermore, the controller **405** has set the hot water heater **441** to the "pre-cleaning mode, main washing mode, post-cleaning mode" and caused it to heat water. Hence, the trunk of the nozzle **473** is cleaned with hot water squirted from the jetting portion **479**.

Next, the controller **405** switches the flow rate switching valve **471** and the flow channel switching valve **472** from "bypass **2**" to "bottom water force **5**" (timing t**207**-t**208**) and performs main washing (bottom washing) (timing t**208**-t**209**). Here, for instance, if the user changes the setting of the water force in "bottom washing" from "water force **5**" to "water force **3**" by the manipulator **500**, then the controller **405** switches the flow rate switching valve **471** and the flow channel switching valve **472** from "bottom water force **5**" to "bottom water force **3**" (timing t**209**-t**210**). Then, the controller **405** continues main washing at "water force **3**" (timing t**210**-t**211**).

In this main washing, the controller **405** does not cause the electrolytic cell unit **450** to be energized, and does not cause it to produce sterilizing water. Hence, there is no case where sterilizing water is squirted at the user's body. Furthermore, the hot water heater **441** is set to the "pre-cleaning mode, main washing mode, post-cleaning mode". Hence, the user's body is washed with hot water heated by the hot water heater **441**.

Next, when the user pushes a "stop switch", not shown, on the manipulator **500**, the controller **405** switches the flow rate switching valve **471** and the flow channel switching valve **472** from "bottom water force **3**" to "bypass **2**" so that water can be squirted from the jetting portion **479** provided in the nozzle cleaning chamber **478** (timing t**211**). Next, the controller **405** houses the nozzle **473** advanced to the position of "bottom washing" in the casing **400** (timing t**212**-t**213**).

At this time, the controller **405** has opened the solenoid valve **431**, does not cause the electrolytic cell unit **450** to be energized, and does not cause it to produce sterilizing water. Furthermore, the controller **405** has set the hot water heater **441** to the "pre-cleaning mode, main washing mode, post-cleaning mode" and caused it to heat water. Hence, the trunk of the nozzle **473** is cleaned with hot water squirted from the jetting portion **479**.

Next, with the nozzle **473** housed in the casing **400**, the controller **405** switches the flow rate switching valve **471** and the flow channel switching valve **472** from "bypass **2**" to "SC". Thus, post-cleaning is performed by jetting water from all the jetting ports **474** for "bottom washing" and "bidet washing" (timing t**213**-t**214**).

At this time again, the controller **405** has opened the solenoid valve **431**, does not cause the electrolytic cell unit **450** to be energized, and does not cause it to produce sterilizing water. Furthermore, the controller **405** has set the hot water heater **441** to the "pre-cleaning mode, main washing mode, post-cleaning mode" and caused it to heat water. Hence, the region of the jetting ports **474** of the nozzle **473** is cleaned with hot water jetted by the jetting ports **474** themselves.

Furthermore, the controller **405** closes the solenoid valve **431** and switches the flow rate switching valve **471** and the flow channel switching valve **472** from "SC" to "origin" (timing t**214**). Furthermore, the controller **405** changes the setting of the hot water heater **441** from the "pre-cleaning mode, main washing mode, post-cleaning mode" to the "keep-warm control mode" (timing t**214**).

Next, the user performs "bottom drying" as appropriate and leaves the toilet seat **200** (timing t**215**). Then, after the lapse of a prescribed time (here e.g. approximately 25 seconds), the controller **405** switches the flow rate switching valve **471** and the flow channel switching valve **472** from "origin" to "SC" and enables jetting from all the jetting ports **474** for "bottom washing" and "bidet washing" (timing t**216**). Furthermore, the controller **405** opens the solenoid valve **431** (timing t**216**).

Next, the controller **405** starts energizing the electrolytic cell unit **450** (timing t**217**). Furthermore, the controller **405** changes the setting of the hot water heater **441** from the "antifreeze mode" to the "heater energization disable mode" (timing t**217**). That is, the controller **405** stops energizing the hot water heater **441**. Thus, "pre-sterilization" of the jetting ports **474** is performed.

Here, after opening the solenoid valve **431** (timing t**216**), the controller **405** starts energizing the electrolytic cell unit **450** (timing t**217**). Hence, even if hot water exists in the electrolytic cell unit **450**, the hot water is drained and replaced by unheated water. That is, the controller **405** can start energizing the electrolytic cell unit **450** after draining the hot water in the electrolytic cell unit **450** and replacing it by unheated water. Thus, electrolysis of hot water can be suppressed, and increase of production of scale can be suppressed.

Furthermore, the controller **405** starts energizing the electrolytic cell unit **450** after opening the solenoid valve **431**. This can prevent energization in the state of no water between the electrodes of the electrolytic cell unit **450**. Hence, local energization of the anode plate **454** and the cathode plate **455** can be prevented. Thus, decrease of lifetime of the anode plate **454** and the cathode plate **455** can be suppressed.

Next, the controller **405** switches the flow rate switching valve **471** and the flow channel switching valve **472** from "SC" to "origin" (timing t**218**). Next, the controller **405** advances the nozzle **473** housed in the casing **400** to the position of "forefront" (timing t**219**-t**220**). At this time, the controller **405** has opened the solenoid valve **431** and caused the electrolytic cell unit **450** to be energized. Hence, the trunk of the nozzle **473** is sterilized with sterilizing water squirted from the jetting portion **479**. Next, the controller **405** houses

the nozzle **473** advanced to the position of "forefront" in the casing **400** (timing t**220**-t**221**). Also at this time, the controller **405** has opened the solenoid valve **431** and caused the electrolytic cell unit **450** to be energized. Hence, the trunk of the nozzle **473** is sterilized with sterilizing water squirted from the jetting portion **479**.

Next, the controller **405** switches the flow rate switching valve **471** and the flow channel switching valve **472** from "origin" to "SC" and enables jetting from all the jetting ports **474** for "bottom washing" and "bidet washing" (timing t**221**). Thus, "post-sterilization" of the jetting ports **474** is performed.

Next, the controller **405** stops energizing the electrolytic cell unit **450** and changes the setting of the hot water heater **441** from the "heater energization disable mode" to the "antifreeze mode" (timing t**222**). Furthermore, the controller **405** closes the solenoid valve **431** and switches the flow rate switching valve **471** and the flow channel switching valve **472** from "SC" to "origin" (timing t**222**).

Next, when a prescribed time (here e.g. approximately 8 hours) has elapsed after the last use of the sanitary washing apparatus **100**, the controller **405** switches the flow rate switching valve **471** and the flow channel switching valve **472** from "origin" to "SC" and enables jetting from all the jetting ports **474** for "bottom washing" and "bidet washing" (timing t**223**). Furthermore, the controller **405** opens the solenoid valve **431** (timing t**223**). Subsequently, the controller **405** starts energizing the electrolytic cell unit **450** (timing t**224**). Thus, regular sterilization in the flow channel **20** and of the jetting ports **474** is performed.

Next, the controller **405** stops energizing the electrolytic cell unit **450** (timing t**225**). Furthermore, the controller **405** closes the solenoid valve **431** and switches the flow rate switching valve **471** and the flow channel switching valve **472** from "SC" to "origin" (timing t**225**).

In this specific example, when performing "pre-sterilization", the controller **405** changes the setting of the hot water heater **441** from the "antifreeze mode" to the "heater energization disable mode" (timing t**217**). However, the embodiment is not limited thereto. When performing "pre-sterilization", the controller **405** may leave the hot water heater **441** set to the "antifreeze mode". That is, during timing t**217**-t**222**, the controller **405** may leave the hot water heater **441** set to the "antifreeze mode".

In this case, if the water temperature falls below a prescribed temperature (e.g. approximately 6° C.), the controller **405** energizes the hot water heater **441** (turns on/off the hot water heater **441**) to increase the water temperature. Here, the amount of energization for antifreeze is an amount of energization such that the temperature of water heated by the hot water heater **441** is lower than the preset value of the temperature of hot water for body washing. Thus, also in this case, increase of production of scale can be suppressed. Here, in the region other than cold climate areas, the hot water heater **441** is virtually stopped even in the "antifreeze mode".

On the other hand, in the specific example shown in FIG. **9**, when performing "pre-sterilization", the controller **405** changes the setting of the hot water heater **441** from the "antifreeze mode" to the "heater energization disable mode" (timing t**217**). That is, when performing "pre-sterilization", the controller **405** stops energizing the hot water heater **441**. In this case, even if the water temperature falls below a prescribed temperature (e.g. approximately 6° C.), the controller **405** does not cause the hot water heater **441** to be energized. However, the solenoid valve **431** is opened, and water is passed in the flow channel **20**. Hence, there is little danger of water freezing.

As described above, according to the embodiment, the controller **405** stops energizing the hot water heater **441** or reduces the amount of energization of the hot water heater **441** when the controller **405** starts energizing the electrolytic cell unit **450** and causes the electrolytic cell unit **450** to produce sterilizing water to sterilize the nozzle **473**. Hence, when the controller **405** starts energizing the electrolytic cell unit **450**, the water in the electrolytic cell unit **450** is unheated water. Alternatively, when the controller **405** starts energizing the electrolytic cell unit **450**, the water in the electrolytic cell unit **450** is replaced by unheated water. Thus, increase of production of scale can be suppressed.

The embodiments of the invention have been described above. However, the invention is not limited to the above description. Those skilled in the art can suitably modify the above embodiments, and such modifications are also encompassed within the scope of the invention as long as they include the features of the invention. For instance, the shape, dimension, material, and layout of various components in the sanitary washing apparatus **100** and the like, and the installation configuration of the nozzle **473** and the nozzle cleaning chamber **478** are not limited to those illustrated, but can be suitably modified. Furthermore, the prescribed time after the seating sensor **404** comes not to sense the user seated on the toilet seat **200** until the controller **405** starts energizing the electrolytic cell unit **450** (approximately 25 seconds in the example described above with reference to FIGS. **4** and **9**) can be suitably modified. Furthermore, the prescribed time after the last use of the sanitary washing apparatus **100** until the controller **405** performs regular sterilization (approximately 8 hours in the example described above with reference to FIGS. **4** and **9**) can be suitably modified. Furthermore, it is more desirable that the jetting timing of the sterilizing water jetting nozzle for jetting sterilizing water to the surface of the bowl **801** be after cleaning the toilet stool. However, the jetting timing is not limited thereto, but can be suitably modified.

Furthermore, various components in the above embodiments can be combined with each other as long as technically feasible. Such combinations are also encompassed within the scope of the invention as long as they include the features of the invention.

What is claimed is:

1. A sanitary washing apparatus comprising:

a nozzle including a jetting port and configured to squirt water from the jetting port to wash a user's body;

a flow channel configured to guide water supplied from a water supply source to the jetting port;

an electrolytic cell provided midway along the flow channel and being operable to electrolyze the water to produce sterilizing water;

a heating device provided on the flow channel on upstream side of the electrolytic cell;

a nozzle cleaning device configured to clean and sterilize the nozzle with the water heated by the heating device and the sterilizing water produced by the electrolytic cell;

a flow channel switching valve provided on the flow channel on downstream side of the electrolytic cell and configured to switch the sterilizing water supply to the nozzle and the nozzle cleaning device; and

a controller configured to perform control for stopping energization of the electrolytic cell when energizing the heating device,

the flow channel on which the heating device is provided being the same as the flow channel on which the electrolytic cell is provided, and

the channel switching valve being located in a portion of the flow channel connecting the electrolytic cell to the nozzle.

2. The sanitary washing apparatus according to claim **1**, wherein when energizing the electrolytic cell, if water heated by the heating device exists in the electrolytic cell, the controller stops energizing of the heating device, and the controller starts energizing the electrolytic cell after the heated water in the electrolytic cell is replaced by unheated water.

3. The sanitary washing apparatus according to claim **1**, further comprising:

a human body sensing device configured to sense utilization by the user,

wherein the controller causes the electrolytic cell to be energized and the nozzle to be sterilized with the sterilizing water after the human body sensing device comes to sense no utilization by the user.

4. The sanitary washing apparatus according to claim **3**, wherein the controller causes the electrolytic cell to be energized and the nozzle to be sterilized with the sterilizing water after a prescribed time after the human body sensing device comes to sense no utilization by the user.

5. The sanitary washing apparatus according to claim **1**, wherein the sterilizing water is water containing hypochlorous acid.

6. The sanitary washing apparatus according to claim **1**, further comprising:

a sterilizing water jetting nozzle provided on the flow channel on downstream side of the electrolytic cell and configured to jet the sterilizing water to a surface of a bowl of a toilet stool.

7. The sanitary washing apparatus according to claim **1**, wherein the sterilizing water selectively supplied to the nozzle cleans or sterilizes the nozzle from inside of the nozzle and the sterilizing water selectively supplied to the nozzle cleaning device cleans or sterilize the nozzle from outside of the nozzle.

8. The sanitary washing apparatus according to claim **1**, wherein the nozzle cleaning device is configured to clean or sterilize the nozzle from outside of the nozzle.

9. The sanitary washing apparatus according to claim **1**, wherein the nozzle cleaning device comprises a nozzle cleaning chamber and a jetting portion, and the jetting port of the nozzle is configured to be substantially housed in the nozzle cleaning chamber in a housed state so that the jetting portion of the nozzle cleaning device can sterilize the jetting port and outer peripheral surface of the nozzle by squirting the water heated by the heating device or the sterilizing water produced by the electrolytic cell to the jetting port and outer peripheral surface of the nozzle.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO.	: 9,328,497 B2
APPLICATION NO.	: 13/162681
DATED	: May 3, 2016
INVENTOR(S)	: Yo Morotomi et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Specification,

Column 2, line 60, replace "tinning" with -- timing --.

Column 9, line 53, replace "(timing U05)" with -- (timing t105) --.

Signed and Sealed this
Eighteenth Day of October, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office